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NATIONAL DAM SAFETY PROGRAM. BIG LAKE DAM (MO 30457), MISSISSIP--ETC(U)
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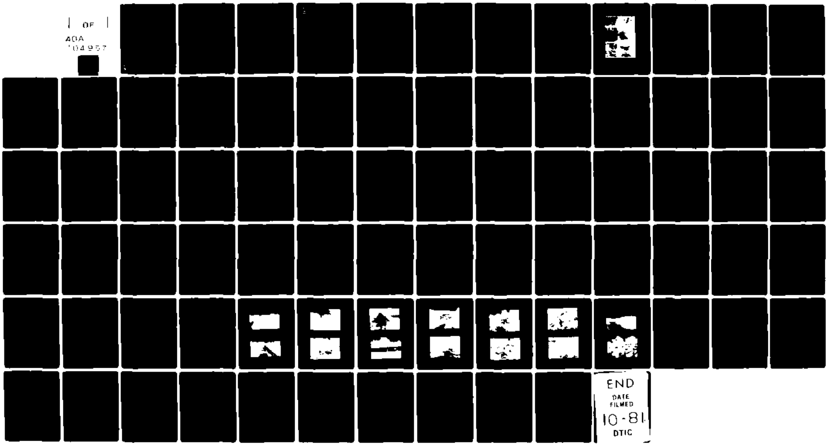

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AD A104957

BIG LAKE DAM
JEFFERSON COUNTY, MISSOURI
MO. 30457

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JULY 1981

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY

ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Big Lake Dam (Mo. 30457) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Big Lake Dam (Mo. 30457).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. The spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SIGNED

21 JUL 1981

SUBMITTED BY: ______________________ Chief, Engineering Division ______ Date

23 JUL 1981

APPROVED BY: ______________________ Colonel, CE, Commanding ______ Date

SIGNED

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BIG LAKE DAM
JEFFERSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30457

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
PRC CONSOER TOWNSEND, INC.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JULY 1981

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Big Lake Dam, Missouri Inventory No. 30457
State Located:	Missouri
County Located:	Jefferson
Stream:	Unnamed tributary of Joachim Creek
Date of Inspection:	May 8, 1981

Assessment of General Condition

Big Lake Dam was inspected by the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture) in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Located within the estimated damage zone of three miles downstream of the dam are at least 12 dwellings, one building, two downstream dams (Sunrise Lake Dam (Mo. 31190) and Clear Lake Dam (Mo. 30437)), and a county highway (Highway V), which parallels Joachim Creek, all of which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Big Lake Dam is in the small size classification since it is 39.0 feet high and has a maximum reservoir impoundment of 160 acre-feet.

The inspection and evaluation indicate that the spillway of Big Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Big Lake Dam being a small size dam with a high hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping the dam. Considering the small size of the dam, the reservoir storage capacity and the number of dwellings in the downstream hazard zone, one-half of the Probable Maximum Flood is considered the appropriate spillway design flood for Big Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately 35 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The overall condition of the dam appears to be fair; however, the seepage through the foundation bedrock jeopardizes the safety of the dam and will require further attention. Other deficiencies noted by the inspection team, which will require remedial measures, included: the deterioration of the concrete of the spillway inlet wall as evidenced by cracks in the concrete and the displacements at the cracks; the severe erosion in the spillway discharge channel and the potential for further erosion in the spillway; the large cut across the downstream slope; the erosion of the upstream slope due to wave action and the erosion gully along the right abutment/embankment contact due to surface runoff; the trees and brush on the embankment slopes; a need for periodical maintenance of the grass cover; and a lack of a maintenance schedule. There also exists a need for periodic inspection by a qualified engineer. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above. Increasing the spillway capacity and further investigation of the seepage should be undertaken on a high priority basis. All other remedial measures should be undertaken within a reasonable period of time.

STATE OF MISSOURI
WALTER
G. SHIFRIN
NUMBER
E-6834
PROFESSIONAL ENGINEER

Walter G. Shifrin, P.E.

Overview of Big Lake Dam

NATIONAL DAM SAFETY PROGRAM

BIG LAKE DAM, I.D. No. 30457

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BIG LAKE DAM, Missouri Inv. No. 30457

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Big Lake Dam was carried out under Contract DACW 43-81-C-0063 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture).

b. Purpose of Inspection

The visual inspection of Big Lake Dam was made on May 8, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site and of the structural adequacy of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the northwest abutment or side, and right to the southeast abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Paul N. Shy. Mr. Shy designed and constructed the dam. No design or "as-built" drawings for the dam or spillway were available.

The dam is a homogeneous, rolled, earthfill structure with a 12-foot-wide core trench excavated to solid bedrock, according to Mr. Shy. The alignment of the dam is straight between earth abutments. A plan and elevation of the dam are shown on Plate 4 and Photos 1 through 3 show views of the dam. The top of dam has a length of 475 feet between the right abutment and the spillway. The minimum elevation of the top of dam was found to be 802.9 feet above mean sea level (M.S.L.) at the spillway and at the maximum section of the dam. From the spillway, the top of dam sloped upward and downward in varying degrees to the right abutment contact. The right end of the dam was surveyed to be 2.5 feet higher than the left end. The embankment has a top width of 13.5 feet and a maximum structural height of 39.0 feet. The downstream slope was measured to be 1 vertical to 2 horizontal (1V to 2H). The upstream slope varied from 1V to 1.25H from the top of the dam to the normal water surface level to 1V to 2.5H below the normal water surface level.

There is only one spillway at this damsite which consists of a broad-crested weir cut into the left abutment (see Photo 5). The weir has a crest length and width of 24 feet and is surfaced with gravel. The inlet of the spillway is defined by a concrete wall that forms the leading edge of the weir (see Photo 6). The wall has a top width of 1.7 feet and is 0.6 feet high at the centerline of the spillway. The concrete wall is also the control section of the spillway. There is a two-inch-thick by 30-inch-wide concrete pad running along the length of the downstream edge of the weir. The discharge channel is earth-lined. The channel shape is trapezoidal at the broad-crested weir and gradually changes to a V-shaped channel about 100 feet downstream (see Photo 8). The discharge channel alignment is perpendicular to the axis of the dam at the spillway outlet. The alignment then curves to become parallel to the axis approximately 75 feet downstream of the spillway outlet. The discharge channel intersects the downstream channel about 150 feet downstream of the dam toe.

No low-level outlet or outlet works are provided for this dam.

b. Location

Big Lake Dam is located in Jefferson County in the State of Missouri on an unnamed tributary of Joachim Creek. The location of the dam on the 7.5 minute series of the U.S. Geological Survey maps is found in the northwest quarter of Section 1 of Township 38 North, Range 4 East, of the Vineland, Missouri Quadrangle Sheet (Advance Print, see Plate 2). The dam is located approximately 6.5 miles southeast of De Soto (see Plate 1).

c. Size Classification

The maximum reservoir impoundment of Big Lake Dam is 160 acre-feet. This is less than 1,000 acre-feet but more than 50 acre-feet, which would classify it as a "small" size dam. The maximum height of the dam of 39.0 feet is less than 40 feet and greater than 25 feet, which also classifies it as a "small" size dam. The size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the

downstream area, our findings concur with this classification. Located within the estimated damage zone, which extends approximately three miles downstream of the dam, are at least 12 dwellings, one building, two downstream dams (Sunrise Lake Dam (Mo. 31190) and Clear Lake Dam (Mo. 30437)), and a county highway (Highway V), which parallels Joachim Creek. Photo 14 shows a view of some dwellings in the downstream hazard zone.

e. Ownership

Big Lake Dam is privately owned by Mr. Paul N. Shy. The mailing address is as follows: Mr. Paul N. Shy, Route 3, De Soto, Missouri, 63020.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

According to Mr. Shy, the dam was designed and constructed by his own construction company during 1960 and 1961. No drawings or specifications pertaining to the design or construction of the dam were available.

The following information, which pertains to the construction of the dam, was obtained from Mr. Shy. The dam was constructed using rubber-tired scrapers and bulldozers. The embankment material was placed on the fill in thin layers and the compaction of the material was achieved by the activity of the earthmoving equipment; however, no compaction control was employed. Material used for the homogeneous embankment was a fine clay borrowed from the reservoir area. A 12-foot-wide core trench was excavated along the axis of the dam to solid bedrock.

h. Normal Operational Procedures

Normal operational procedure is to allow the reservoir to remain as full as possible. The water level is basically controlled by rainfall, runoff, evaporation and the crest elevation of the spillway. Nevertheless, leakage through the foundation bedrock, as later described in Section 3.1b, has been a problem at this damsite for several years. Due to this leakage, the water surface level in the reservoir has steadily dropped in recent years to its present elevation. The water surface was 16.9 feet below the crest of the spillway on the day of the inspection.

1.3 Pertinent Data

a. Drainage Area (square miles): 0.42

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): 180

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 1,039

c. Elevation (Feet above M.S.L.)

Top of dam (minimum): 802.9

Spillway crest: . . . . 799.0 (assumed)*

Normal Pool: 799.0

Maximum Experienced Pool: 800.5

Observed Pool: 782.1

d. Reservoir

Length of pool with water surface at top of dam elevation (feet): 1,700

e. Storage (Acre-Feet)

Top of dam (minimum): 160

Spillway crest: 97

Normal Pool: 97

Maximum Experienced Pool: 117

Observed Pool: 11

f. Reservoir Surfaces (Acres)

Top of dam (minimum): 20.5

Spillway crest: 10.0

Normal Pool: 10.0

Maximum Experienced Pool: 16.0

Observed Pool: 2.0

g. Dam

Type:.	Rolled, Earthfill
Length:.	475 feet
Structural Height:	39.0 feet
Hydraulic Height**:.	39.0 feet
Top width:	13.5 feet
Side slopes:	
Downstream.	1V to 2H (measured)
Upstream.	Varies from 1V to 1.25H from the top of dam to the normal water surface level to 1V to 2.5H below the normal water surface.
Zoning:.	Homogeneous
Impervious core:	None
Cutoff:.	A core trench excavated to bedrock, according to Mr. Shy
Grout curtain:	None
Volume:.	45,500 cu.yds. (estimated)

h. Diversion and Regulating Tunnel. . . . .None

i. Spillway

Type:.	Broad-crested weir with an earth-lined discharge channel, uncontrolled.
Location:.	Left abutment
Length of crest:	24.0 feet
Crest Elevation (feet above M.S.L.): .	799.0

j. Regulating Outlets . . None

* The crest elevation of the spillway is assumed to be the elevation of the reservoir as shown on the U.S.G.S. Vineland, Missouri Quadrangle topographic map (Advance Print). The elevations

of other features of the dam are obtained by using this elevation and field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

No design drawings or data are available for Big Lake Dam.

2.2 Construction

No documented construction records or data are available relative to the construction of the dam, other than the construction history given in Section 1.2g.

2.3 Operation

No documented operational records or data are available for the dam.

2.4 Evaluation

a. Availability

The availability of engineering data consists only of the State Geological Maps, a general soil map of the State of Missouri published by the Soil Conservation Service, and U.S.G.S. Quadrangle Sneets.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. The conclusions presented in this report are based on field measurements, past performance and present condition of the dam. The available data including the field measurements taken by the field inspection team are

considered adequate to evaluate the hydraulic and hydrologic capabilities of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data pertaining to the design or construction of the dam were available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Big Lake Dam was made on May 8, 1981. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Soils
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
James Nettum, P.E.	PRC Engineering Consultants, Inc.	Civil-Structural and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Rupp Reitz	PRC Consoer Townsend, Inc.	Civil-Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be fair; however, a few items of concern were observed and are described below.

The top of dam supports a gravel access road used by the local residents to gain access to their homes (see Photo 2). Evidence of some asphalt paving was observed. Outside of the access road, the top of dam is covered by an unmaintained grass cover. The combination of the gravel surfacing and vegetative covering appeared to provide adequate erosion protection against surface runoff, for no erosion was evident. No major damage due to vehicular traffic was seen. Several small potholes were observed; however, on the day of the inspection, a maintenance crew filled in the potholes with asphalt. No depressions or cracks indicating a settlement of the embankment were apparent. The variation in elevation across the top of dam did not appear to be due to an instability of the embankment. No significant deviation in the horizontal alignment was apparent. According to Mr. Shy, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope is not protected by riprap; consequently, some damage due to wave action was observed at the normal water surface level. The slope above the normal pool elevation is covered by an unmaintained vegetative growth ranging from tall grass to small trees (see Photo 1). A comprehensive inspection of the upper portion of the slope was hampered due to the heavy growth of vegetation. The vegetation below the normal pool elevation ranges from small bushes to a sparse grass covering. No erosion due to surface runoff was observed. A surficial layer of rock was observed on the slope, but it provides little or no protection against wave action. The steepness of the slope above the normal water surface elevation did not appear to be due to instability of the slope but, apparently, was

constructed this way. No depressions, bulges or cracks indicative of an instability of the embankment or foundation were apparent.

The downstream slope is protected by an unmaintained, dense, vegetative cover ranging from tall grass to brush (see Photo 3). A comprehensive inspection of the slope was hampered due to the vegetative growth. Trees ranging in size from small to large are also growing on the slope and along the embankment/abutment contacts. No erosion due to surface runoff was observed on the slope; however, an erosion gully measuring up to four feet wide and three feet deep was seen along the downstream, right abutment/embankment contact (see Photo 4). No bulges, depressions or cracks indicative of a major slope movement were apparent.

According to Mr. Shy, leakage through a seam in the foundation bedrock has been occurring at the damsite for several years. Physical evidence of this seepage was observed downstream of the dam. At the toe of the dam, an area of cattails, boggy ground and standing water was observed. The cattails tend to indicate that moisture is generally present in the area. No measurable flow of water was observed at the damsite; however, approximately 600 feet downstream of the dam, flowing water, estimated to have a flow rate of approximately one gallon per minute, was observed in the downstream channel. Tracing the channel back to the damsite, no evidence was found that would indicate the exact location where the seepage was exiting; however, standing water and boggy ground was seen in the downstream channel for the entire distance. No detrimental effects due to the seepage were observed on the embankment.

According to Mr. Shy, two attempts have been made to stop the leakage. One attempt consisted of placing one-inch diameter, plastic grout pipes through the embankment and into the foundation. Grout was then injected into the pipes. This

attempt failed; however, the reservoir did fill up sometime after the grouting took place. Ten plastic pipes, placed parallel to the axis of the dam, were observed along the top of dam. The second attempt to stop the leakage consisted of excavating a trench along the toe of the dam to the foundation bedrock to locate the source of the seepage. Once the source was located the trench was to be backfilled with an impervious material. This attempt progressed no further than the partial excavation of the trench as evidenced by a large cut across the downstream slope above the toe of the dam (see Photo 3). The cut was approximately eight feet wide and four feet deep.

Both abutments slope gently upward from the dam. No instabilities or seepage were observed on either abutment. No erosion felt to be detrimental to the safety of the dam or abutment was apparent on either abutment, other than the erosion mentioned along the right abutment contact above and the erosion in the spillway discharge channel described in Section 3.1d..

According to Mr. Shy, there has been some muskrat activity in the reservoir in the past; however, the muskrats are annually trapped. No evidence of burrowing animals was apparent on either the embankment or the abutments.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Joachim Creek in the Salem Plateau section of the Ozark Plateaus Physiographic Province. Deep dissection of topography by major streams is one of the important characteristics of the Salem Plateau section. There is a wide distribution of dolomites and limestones in the Salem Plateau. Cuestaform topography is exhibited in this plateau section consisting of two major escarpments, namely the Crystal Escarpment and Burlington

Escarpment. Deep dissection in dolomites and limestones is a major factor in the development of many springs in this area. A major component of surface discharge of water to the regional drainage is contributed by these springs.

The topography in the vicinity of the damsite is hilly with V-shaped valleys. Elevations of the ground surface range from 1020.0 feet above M.S.L. nearly 0.9 miles south of the damsite to 799.0 feet above M.S.L. at the damsite. The reservoir slopes are generally from 15 to 45 degrees from horizontal and appeared to be stable. The area near the damsite is covered with residual soil deposits consisting of a reddish-brown and orangey-brown mottled, moderately plastic, silty clay with some fine sand and occasional rock fragments less than 1/4 inch in size.

The regional bedrock geology beneath the residual soil deposits in the damsite area as shown on the Geologic Map of Missouri (1979) (see Plate 6) are of the Ordovician age rocks consisting of Decorah Formation, St. Peter Sandstone, Powell Dolomite, Cotter Dolomite, Roubidoux Formation, and Gasconade Dolomite; and the Cambrian age rocks consisting of Eminence Dolomite, Potosi Dolomite, Lamotte Sandstone, and Franconia and Bonneterre Formations. The predominent bedrocks underlying the residual soil deposits in the vicinity of the damsite are the Ordovician age rocks consisting of Powell Dolomite and Roubidoux Formation.

Outcroppings of Ordovician Powell Dolomite (light brownish-gray, fine grained, moderately hard, thinly to moderately bedded, slightly to moderately weathered dolomite) are exposed in the discharge channel of the spillway (see Photos 10 and 11). Intense solution activity, high intensity weathering, and secondary sedimentary internal structures (such as spherulites and concretions) were observed in the rock outcroppings.

No active faults have been identified at the damsite. The closest geologic fault to the damsite is the Ste. Genevieve fault system nearly 0.5 miles northeast of the damsite. The Ste. Genevieve fault had its last movement in the post-Pennsylvanian time and consists of several fault sets that were formed at the same geologic time. Reconnaissance geologic and geomorphic evidence (nonalignment of secondary valleys of the reservoir and unconformity in the expossures of the rock outcropping in the spillway discharge channel, see Photo 11) suggest that there is a possibility that one of these fault sets crosses the dam reservoir, which could be the cause of the leakage through the foundation.

No boring logs or construction reports are available that would indicate foundation conditions encountered during construction. Based on the visual inspection and conversations with Mr. Shy, the embankment probably rests on the highly weathered Ordovician Powell Dolomite bedrock with the core trench excavated to the underlying bedrock. The spillway was cut into the residual soils of the left abutment.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Union-Goss-Gasconade-Peridge in the Ozark Border Association. The soils are basically formed from loess deposits and weathered bedrock. These soils vary from a slowly permeable silty clay to moderately permeable silt loam.

Material removed from the embankment slopes was a reddish-brown, moderately plastic, silty clay with traces of fine to medium sand. Based upon the Unified Soil Classification System, the soil would be classified as a CL. This is an impervious soil type, which generally has the following

characteristics: a coefficient of permeability less than one foot per year, medium shear strength, and a high resistance to piping. This soil type also has a high resistance to erosion under low velocity flow; however, excessive erosion can occur during the high velocity flows that can be expected when the dam is overtopped.

d. Appurtenant Structures

(1) Spillway

There are several top to bottom cracks in the concrete wall of the spillway inlet with separation and displacement of 1/4 to 1/2 inch (see Photo 6). The cracks are due probably to differential settlement of the wall. The surface of the concrete appears sound with no excessive weathering evident. The gravel surfacing of the broad-crested weir is generally smooth and uniform with the exception of one minor depression due probably to vehicular traffic (see Photo 5). The bottom of the discharge channel immediately downstream of the spillway weir is a composite of bare earth marked with erosional rivulets and pieces of concrete (see Photo 7). As the channel begins to bend towards the downstream channel, a mass of dumped debris covers the start of the heavily eroded V-shaped cross section, which has steep bare earth side slopes (see Photo 8). The sides slopes are unprotected as the channel descends toward the downstream channel (see Photo 9). A second mass of dumped debris was observed in the discharge channel at about halfway down the channel.

(2) Outlet Works

No low-level outlet or outlet works are provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 782.1 feet above M.S.L. Although the reservoir has not been able to maintain a constant water surface level due to the leakage through the foundation, the normal pool elevation is taken as 799.0 feet above M.S.L., which is the spillway crest elevation. At the normal water surface level, the reservoir has a surface area of ten acres.

The rim appeared to be stable with no erosional or stability problems observed (see Photo 13). The land around the reservoir slopes gently upward from the reservoir rim and is mostly wooded with grass-covered slopes. A few houses are built around the reservoir rim. No evidence of excessive siltation was observed in the reservoir on the day of the inspection.

f. Downstream Channel

The downstream channel near the dam is the natural streambed with approximate dimensions of two to three feet deep and 30 feet wide. Outside of the streambed, the downstream channel widens into a narrow flood plain. The channel near the damsite is obstructed with trees and brush (see Photo 12).

3.2 Evaluation

The visual inspection did not reveal any conditions which were felt to constitute an unsafe condition at this time; however, the following condition does exist which warrants further attention.

The seepage through the foundation bedrock does not appear to have had any effect on the structural stability of the dam at this time; however, this condition can only worsen with time. It is possible that seepage could weaken the foundation bedrock, which could

cause the bedrock to collapse. This, in turn, could cause the embankment to settle and possibly cause a total failure of the embankment. The seepage could also cause piping of the embankment material, which could lead to the eventual failure of the embankment.

The following conditions were observed which could adversely affect the dam in the future and will require maintenance within a reasonable period of time.

1. The cracks in the inlet wall of the spillway do not appear to be a hazard to the stability of the spillway at the present time. Nonetheless, as the displacement along the cracks increases with time, the spillway, due to its weakened condition, will be more susceptable to damage from future flows.

2. The unprotected earth surfaces of the spillway discharge channel present a real threat to the safety of the spillway. It is anticipated that future flows through the spillway could cause erosion severe enough to jeopardize the stability of the spillway and therefore the safety of the dam.

3. The randomly selected material dumped in the spillway discharge channel does nothing to enhance the stability of the channel. Conversely, the material increases the turbulence in channel discharges thus increasing the erosive capability of spillway flows.

4. The gravel surfacing of the spillway broad-crested weir is not the most desirable method of covering at this location. While the weir crest currently appears stable, future flows through the spillway could erode the spillway surfacing to a point where the stability of the spillway is jeopardized.

5. The large cut across the downstream slope poses a potential danger to the structural integrity of the dam.

6. The erosion due to wave action on the upstream slope and the erosion due to surface runoff along the downstream, right abutment/embankment contact do not appear to affect the stability of the dam in their present condition. However, continual erosion in these areas can only be detrimental to the structural stability of the dam.

7. The unmaintained vegetative cover and trees on the embankment slopes pose a potential danger to the safety of the dam. Depending upon the extent of the root system, the roots of large trees present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm. And, a heavy unmaintained growth of vegetation on the embankment hinders a comprehensive inspection of the dam, which could allow potential problems to go undetected.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Big Lake Dam was built to impound water for recreational use. There are no specific operational procedures which are followed at this damsite. The reservoir is allowed to remain as full as possible. The water surface elevation is controlled by rainfall, runoff, evaporation and the elevation of the spillway crest. At the present time, the reservoir does not maintain a constant water surface level due to leakage through the foundation bedrock.

4.2 Maintenance of Dam

The maintenance of the dam appears to be inadequate. The embankment slopes are covered by an unmaintained vegetative growth ranging from tall grass to large trees. The upstream slope has been eroded by wave action. No riprap protection was observed on the upstream slope. An erosion gully due to surface runoff has been formed along the downstream, right abutment/embankment contact. A large erosion gully has also been formed in the spillway discharge channel. Part of the erosion gully in the spillway has been back-filled just downstream of the spillway weir.

Two attempts have been made to stop the leakage through the foundation bedrock, as described in Section 3.1b. Both attempts were futile and the leakage still exists.

4.3 Maintenance of Operating Facilities

There are no operating facilities associatd with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in use at the damsite, such as an electrical warning system or a manual notification plan.

4.5 Evaluation

The dam appears to be neglected and the maintenance is inadequate at this time. The corrective measures listed in Section 7 should be undertaken within a reasonable period of time to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

No hydrologic and hydraulic design data are available for Big Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Vineland, Missouri Quadrangle topographic map (Advance Print, 7.5 minute series). The spillway and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil group of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication "Hydrometeorological Report No. 33" (April 1956). The 100-year and the 10-year floods were derived from the 100-year and the 10-year rainfalls, respectively, of Ste. Genevieve, Missouri.

b. Experience Data

Records of reservoir stage or spillway discharge are not maintained for this site. However, according to Mr. Shy, the maximum reservoir level was approximately 18 inches above the crest of the spillway.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood and one-half of the Probable Maximum Flood, which is considered to be the appropriate spillway design for this dam, when routed through the reservoir, resulted in overtopping of the dam. The peak inflows of the PMF and one-half of the PMF are 5,516 cfs and 2,758 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 4,483 cfs and 1,571 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 1,039 cfs. The PMF overtopped the dam by 1.98 feet and one-half of the PMF overtopped the dam by 0.59 feet. The total duration of flow over the dam is 1.67 hours during the occurrence of the PMF and 30 minutes during one-half of the PMF. The spillway/reservoir system of Big Lake Dam is capable of accommodating a flood equal to approximately 35 percent of the PMF just before overtopping the dam and will also accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The surface soils on the embankment consist of a silty clay. The broad-crested weir of the spillway and the top of dam support a gravel access road and the downstream slope has a good cover of grass. However, the dam will be overtopped by more than a half of a foot during the occurrence of one-half of the PMF, which could cause severe erosion to the embankment due to the high velocity of flow on its downstream slope and could lead to the eventual failure of the dam. The maximum velocity of flow in the spillway during the one-half PMF will be about 8.5 ft/sec, which will cause further erosion in the spillway discharge channel due to the high velocity of flow.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately three miles downstream of the dam. Located within the damage zone are at least 12 dwellings, one building, two downstream dams (Sunrise Lake Dam (Mo. 31190) and Clear Lake Dam (Mo. 30437)), and a county highway (Highway V), which parallels Joachim Creek. A failure of the dam could also cause the failure of the two downstream dams.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The stability of the dam does not appear to be in jeopardy at this time; however, the seepage through the foundation bedrock could be detrimental to the stability of the embankment, but does not appear to constitute an unsafe condition at this time. The erosion due to wave action on the upstream slope and the erosion gully along the downstream, right abutment/embankment contact do not appear to endanger the structural stability of the embankment in their present condition; however, continual erosion in these areas could be detrimental to the embankment. The large cut across the downstream slope poses a potential danger to structural stability of the dam. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the spillway is questionable. The cracks in the concrete wall control section, the erodible surface of the spillway broad-crested weir, and the severe erosion in the discharge channel all contribute to potential stability problems for the spillway. The spillway is not obstructed and should be able to function properly; however, future flows of any duration through the spillway could severely jeopardize the safety of the dam.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No documented operating records are available relating to the stability of the dam; however, the reservoir does not maintain a relatively constant water surface level due to the leakage through the foundation bedrock. No detrimental effects to the stability of the dam due to the fluctuation in the reservoir level was observed. The water level on the day of inspection was 16.9 feet below the normal pool elevation.

d. Post Construction Changes

The only known modifications to the dam since its construction were the two attempts to stop the leakage through the foundation bedrock. These attempts could have had a positive effect on the structural stability of the dam. Nevertheless, the attempts were futile and the large cut, which remains from the second attempt, poses a potential danger to the stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in the "Recommended Guidelines for Safety Inspection of Dams" as prepared by the Corps of Engineers (see Plate 9). Seismic Zone 2 is characterized by a moderate earthquake hazard. An earthquake of the magnitude that would be expected in Seismic Zone 2 should not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite. The maximum recorded historic magnitude earthquake in the immediate vicinity of the damsite was the July 21, 1967 event of magnitude 4.4 located at a distance of approximately 36 miles southeast of the damsite. This event cannot be correlated with known tectonic structure and is considered to probably be related to the release of accumulated residual strain along a buried pre-Quaternary fault. The attenuation of this event to the damsite would produce a peak ground acceleration of less than 0.05g which would not produce a significant seismic impact on the dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and the visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Big Lake Dam is found to be "Inadequate". The spillway/reservoir system will accommodate about 35 percent of the PMF without overtopping the dam. If the dam is overtopped, the safety of the embankment would be in jeopardy due to the susceptibility of the embankment materials to erosion. High velocity flows on the downstream slope of the dam could cause excessive erosion and eventually lead to a failure of the dam. The spillway could also receive further damage during the occurrence of a severe flood.

The overall condition of the dam appears to be fair; however, the seepage through bedrock jeopardizes the safety of the dam and does warrant further attention. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment, however, appears to have performed satisfactorily without failure since its construction. The dam has never been overtopped, according to Mr. Shy, and no evidence indicating the contrary was observed. The safety of the dam can only be improved if the deficiencies described in Section 3.2 are properly corrected as described in Section 7.2b.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurements, past performance and the present condition of the dam. Documented information on the design hydrology, hydraulic design, operation, and maintenance of the dam was not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The items recommended in paragraph 7.2a, regarding gaining additional spillway capacity, and the first item in paragraph 7.2b, pertaining to the further investigation of the seepage, should be pursued on a high priority basis. The remaining remedial measures recommended in Paragraph 7.2b should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the spillway capacity to pass one-half of the PMF, without overtopping the dam. The spillway should also be adequately protected to prevent excessive erosion during the occurrence of one-half of the PMF.

2. Increase the height of the dam in order to pass one-half of the PMF without overtopping the dam; an investigation should also include studying the effects that increasing the height of the dam would have on the structural stability of the present embankment. The overtopping depth during the occurrence of one-half of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. Further investigation of the seepage through the foundation bedrock should be undertaken to determine the seriousness of the condition. The investigation should be carried out under the direction of a qualified professional engineer and repairs made as required.

2. The cracking and displacement of the concrete of the spillway control section should be closely monitored and repairs made when deemed necessary by a qualified professional engineer.

3. The eroded spillway discharge channel should be repaired and stabilized. This should also include the removal of all randomly dumped materials in the channel.

4. The broad-crested spillway weir should be surfaced with a more erosion resistant material.

5. The large cut on the downstream slope should be backfilled with a suitable material and the material properly compacted.

6. The erosion due to wave action on the upstream slope and the erosion gully along the right abutment/embankment contact should be properly repaired and the areas protected from further damage.

7. The trees and brush on the embankment slopes should be removed from the embankment and regrowth prevented. The grass cover on the embankment, especially on the downstream slope, should be periodically maintained. The grass cover should be retained on the downstream slope to protect it from erosion due to surface runoff and to prevent excessive erosion in the event the dam is overtopped. Removal of trees should be under the guidance of an engineer experienced in the design and construction of earth dams. Indiscriminate clearing could jeopardize the safety of the dam.

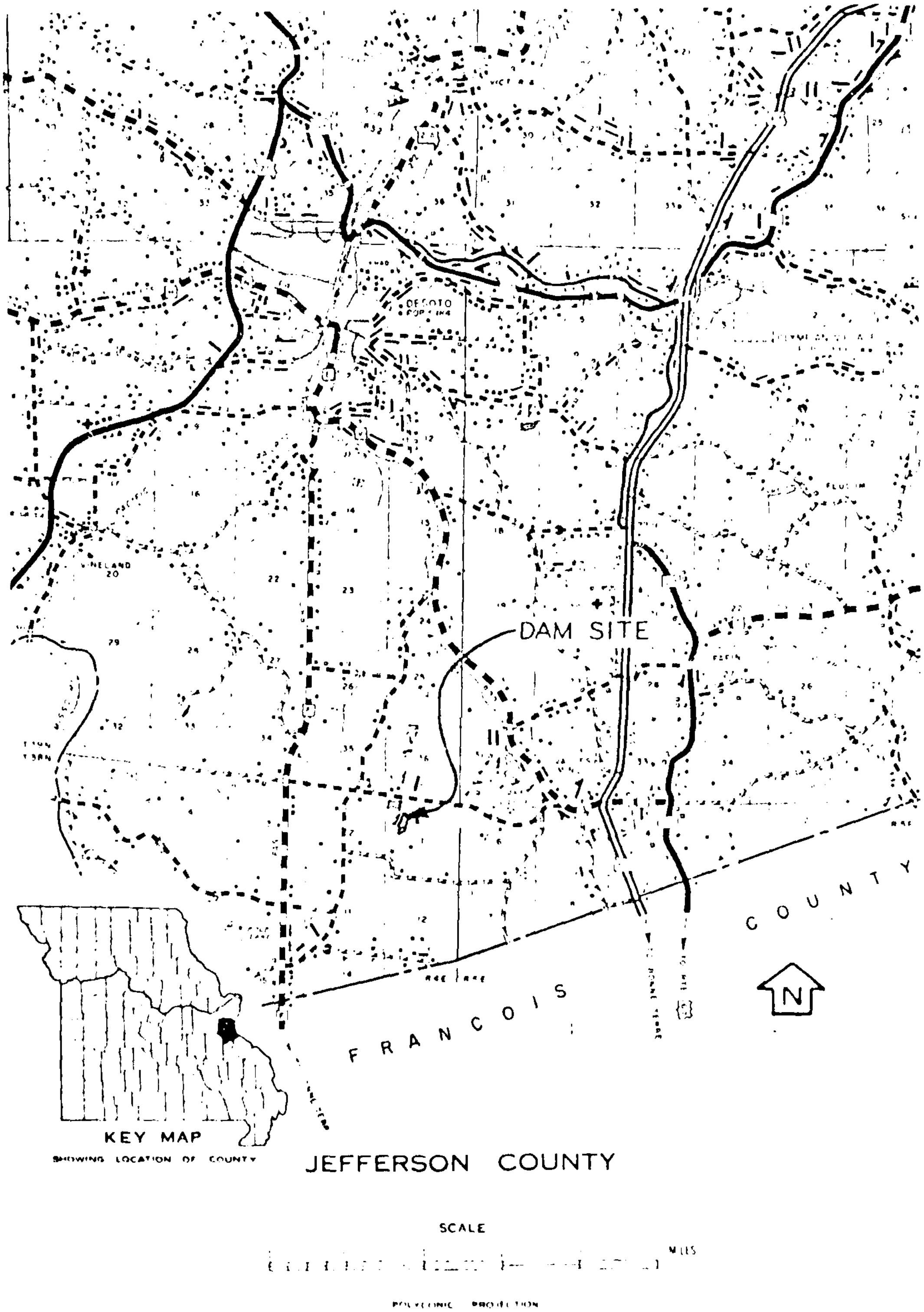
8. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

9. The owner should initiate the following programs:

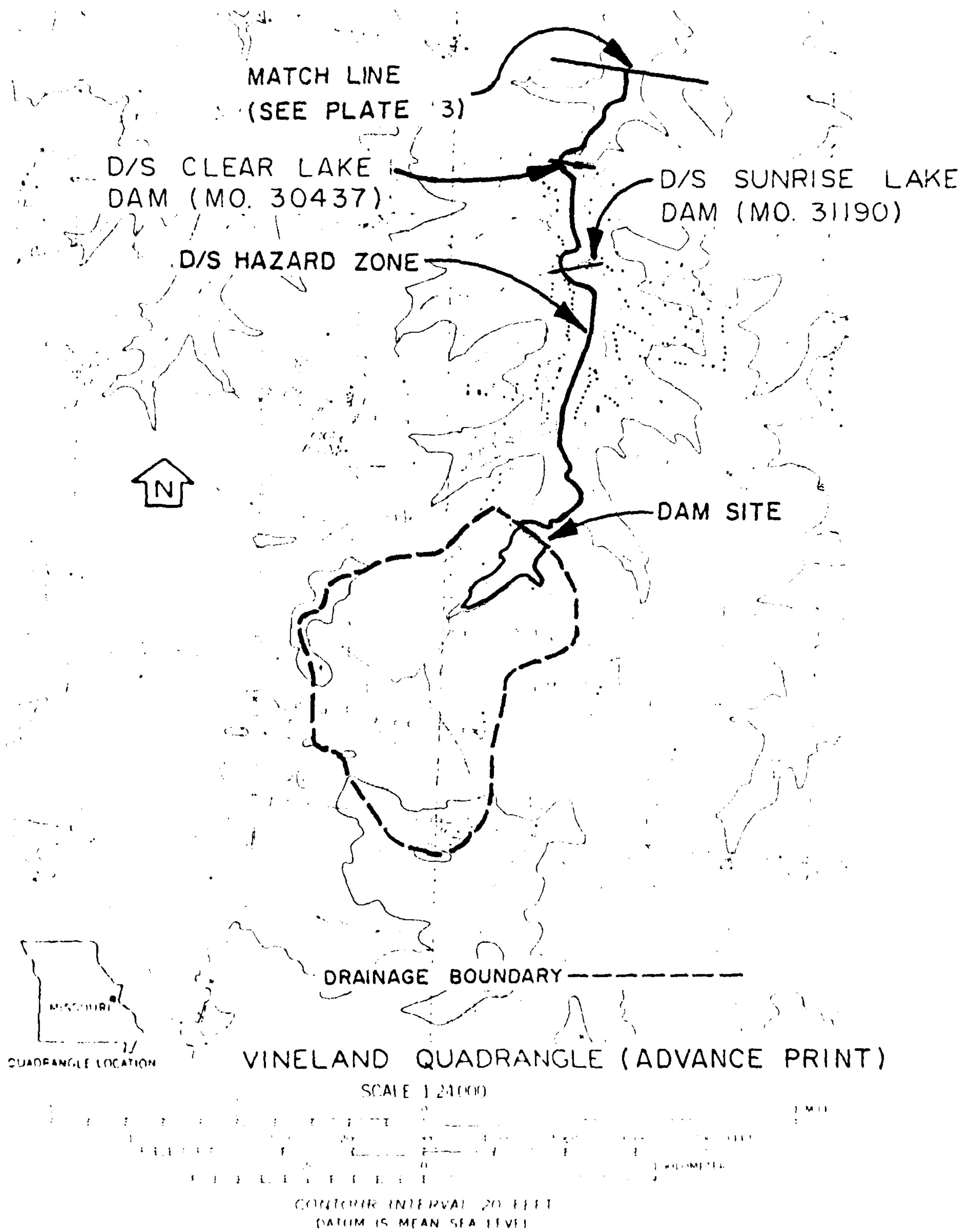
   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

   (b) Set up a maintenance schedule and log all repairs and maintenance.

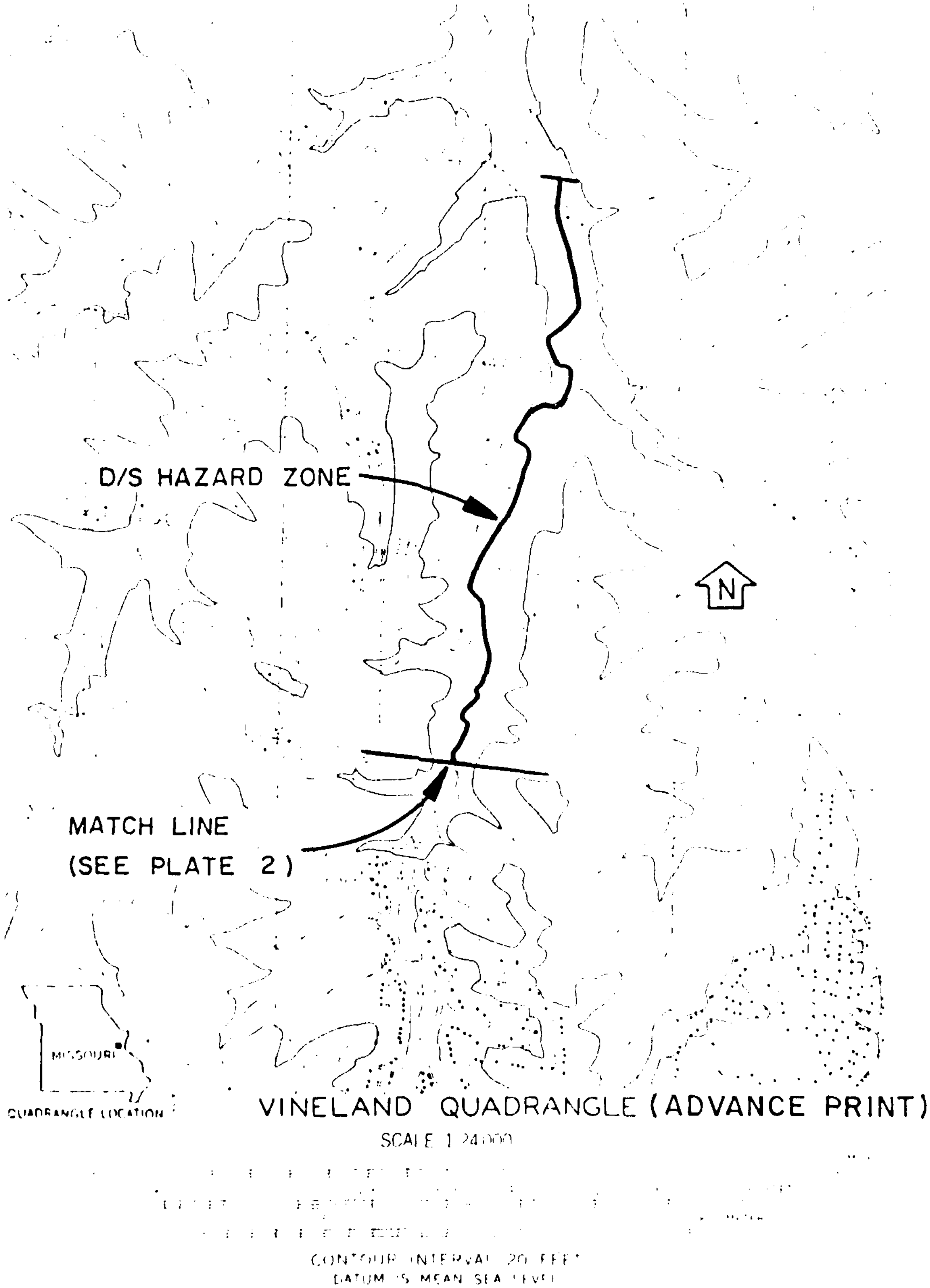
PLATES



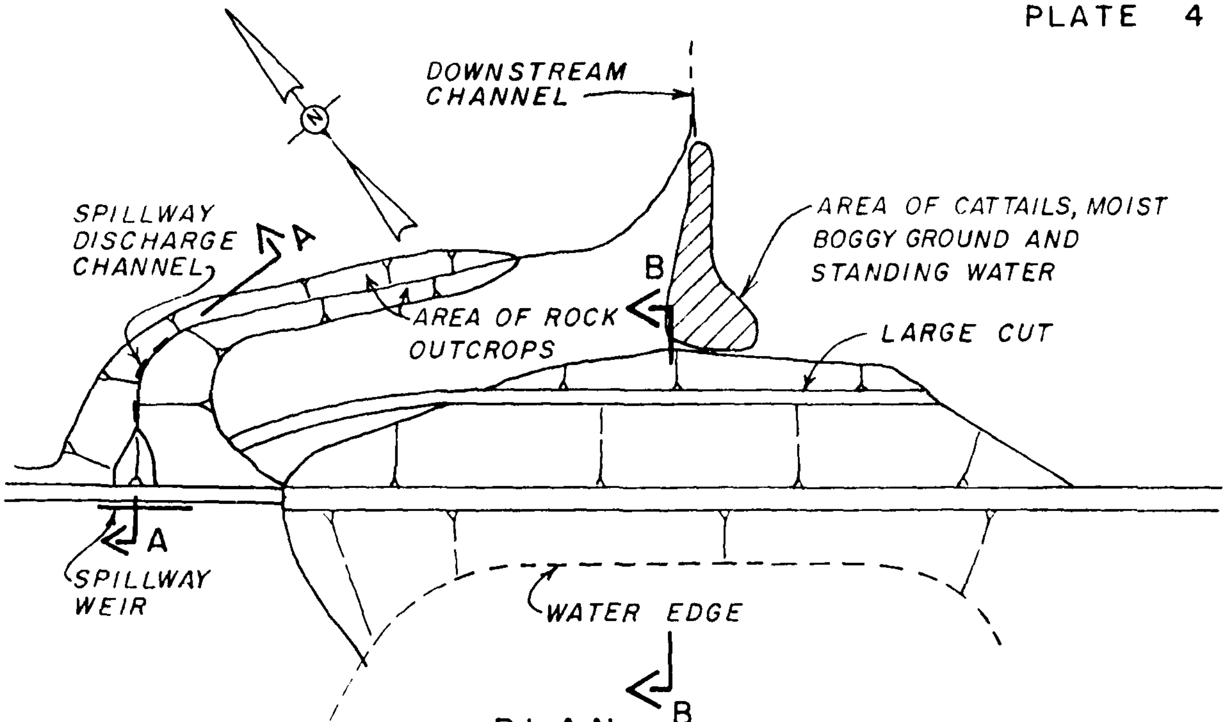
BIG LAKE DAM (MO. 30457)
LOCATION MAP



BIG LAKE DAM (MO. 30457)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 1 OF 2)

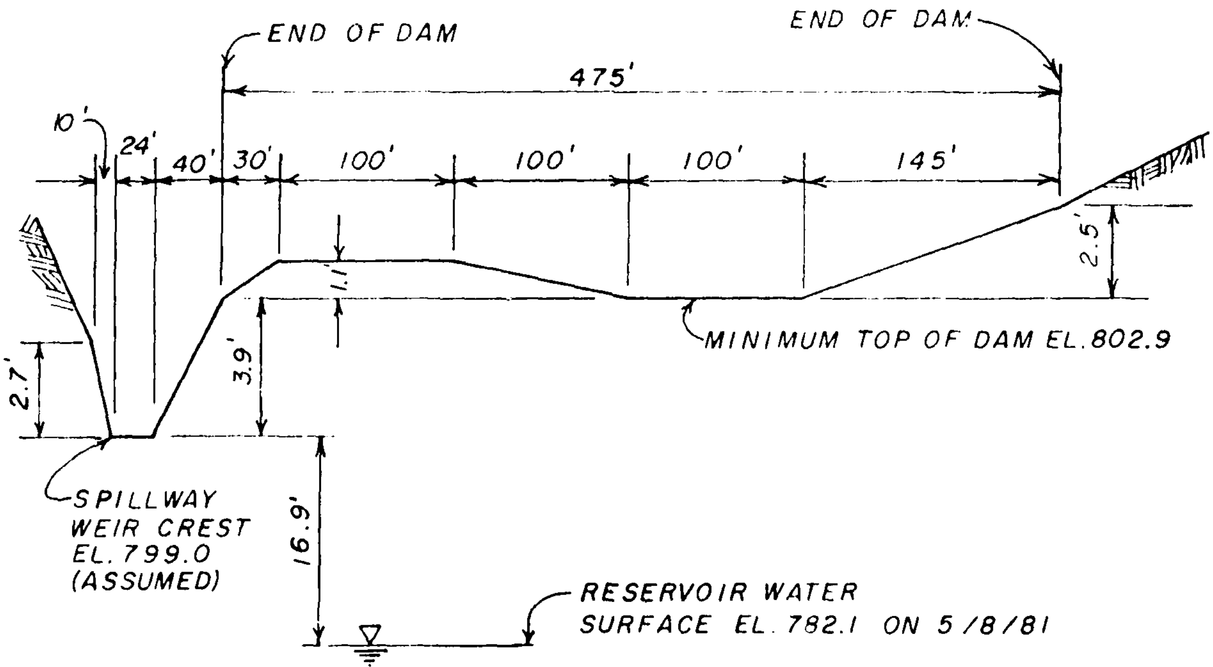


BIG LAKE DAM (MO. 30457)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 2 OF 2)



PLAN

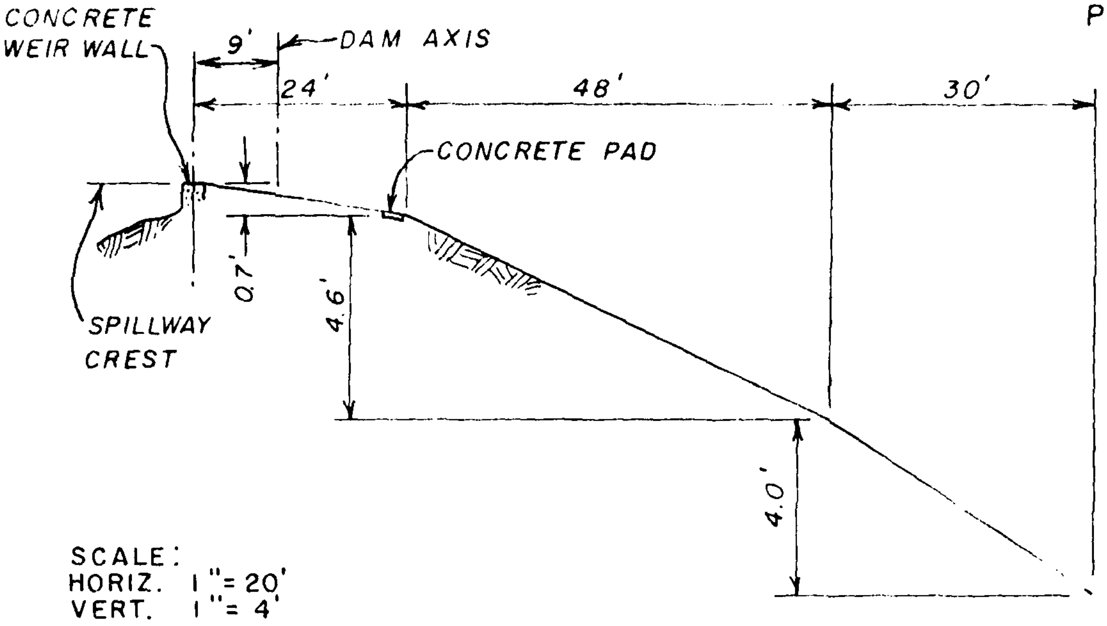
SCALE:
HORIZ. 1" = 100'



SCALE:
HORIZ. 1" = 100'
VERT. NO SCALE

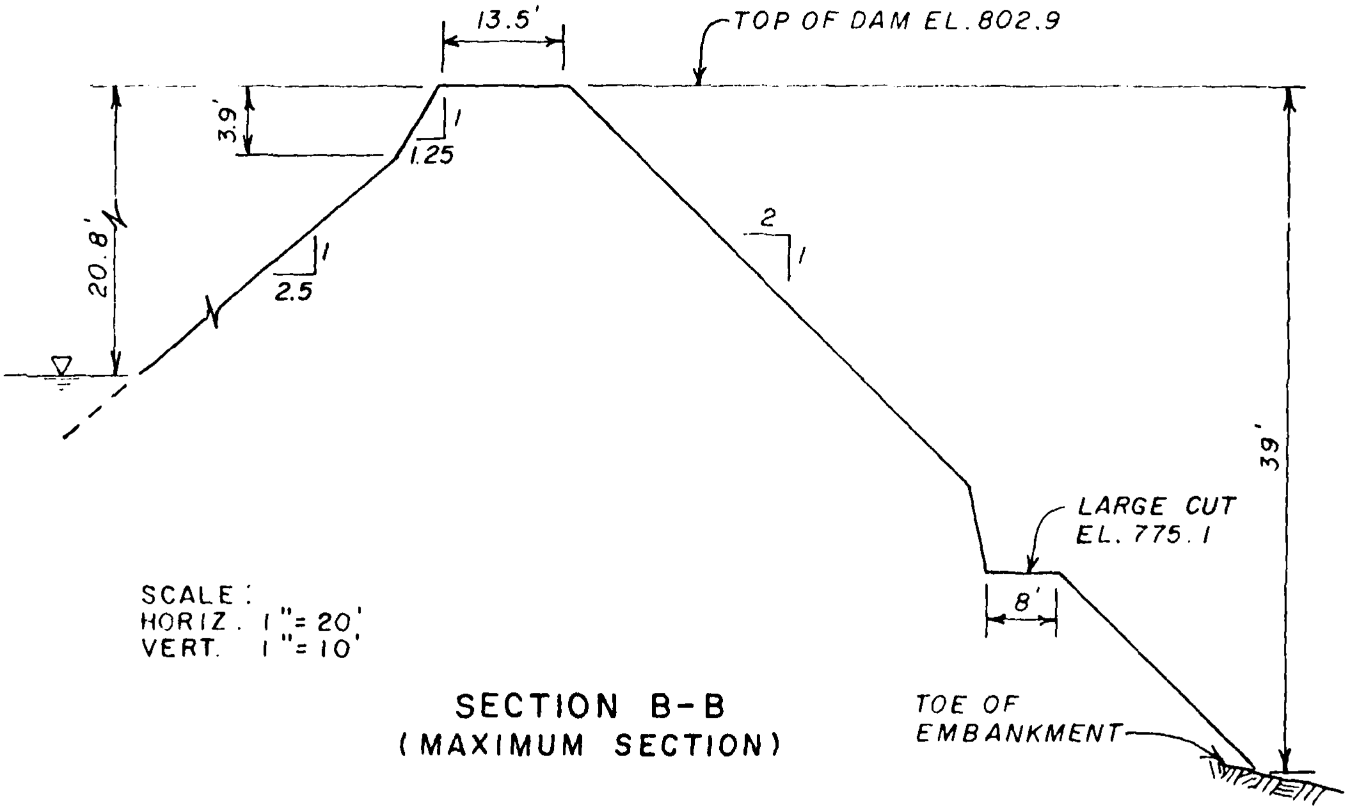
ELEVATION

BIG LAKE DAM (MO. 30457)
PLAN AND ELEVATION
(SHEET 1 OF 2)



SCALE:
HORIZ. 1" = 20'
VERT. 1" = 4'

SECTION A-A
(SPILLWAY PROFILE)

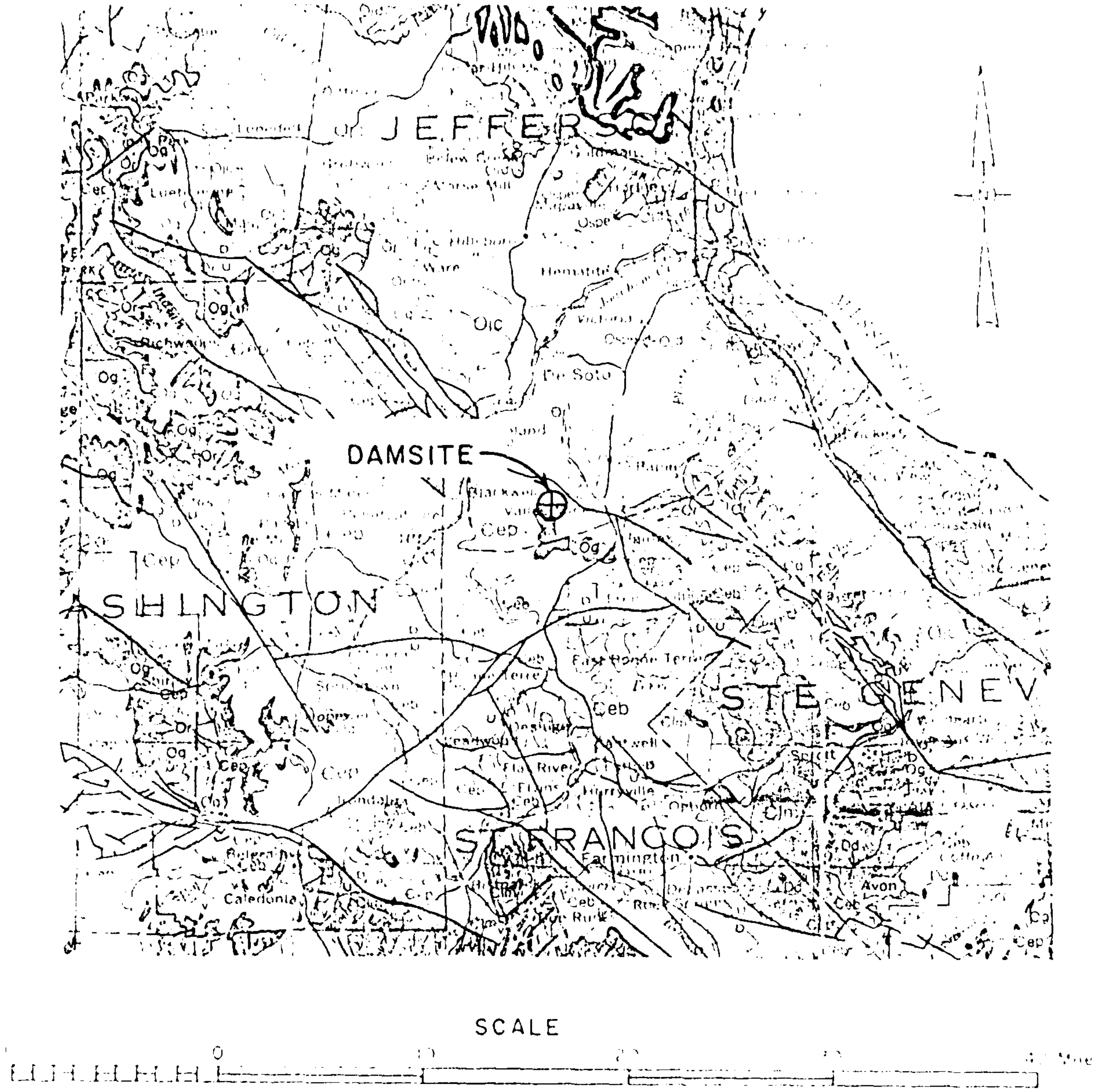


SCALE:
HORIZ. 1" = 20'
VERT. 1" = 10'

SECTION B-B
(MAXIMUM SECTION)

BIG LAKE DAM (MO. 30457)
SPILLWAY PROFILE AND MAXIMUM SECTION
(SHEET 2 OF 2)

PLATE 6



(|) LOCATION OF DAM

NOTE: LEGEND FOR THIS MAP IS ON PLATES 7 AND 8.

REFERENCE
GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP
OF
BIG LAKE DAM

BIG LAKE DAM
PLATE 7

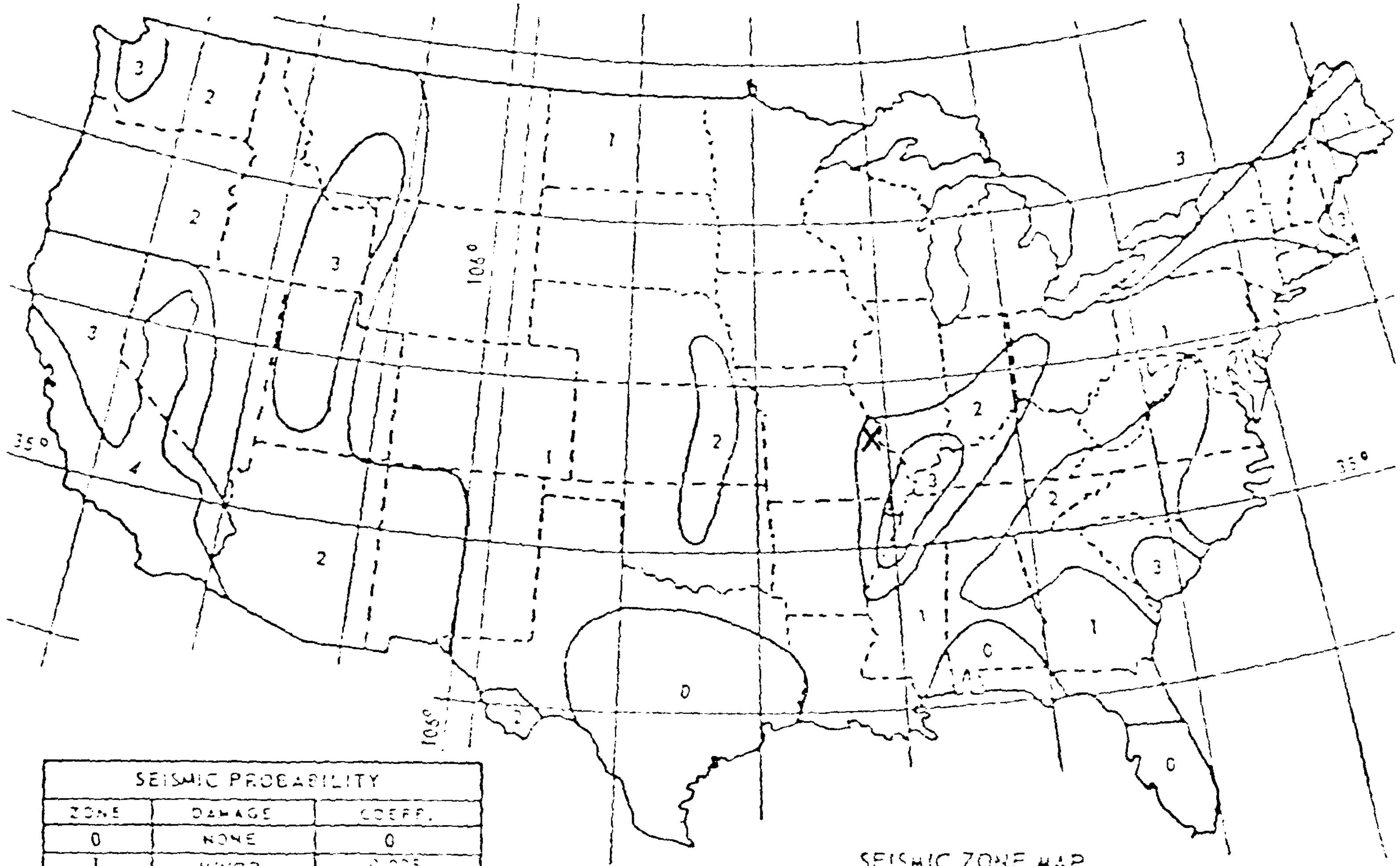
LEGEND

PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
	Mo	KEOKUK – BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
MISSISSIPPIAN	Mk	UNDIFFERENTIATED CHOUTEAU GROUP: LIMESTONE
	Mk	HANNIBAL FORMATION: SHALE AND SILTSTONE
DEVONIAN	Dd	DIATREMES, KIMBERLITES, CARBONATITES
	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Ospe	ST. PETER SANDSTONE, EVERTON FORMATION
ORDOVICIAN	Ojd	JOACHIM DOLOMITE
	Ojc	POWELL DOLOMITE, COTTER DOLOMITE
	Or	ROUBIDOUX FORMATION: INTERBEDS OF CHERTY LIMESTONE AND SANDSTONE
	Og	GASCONADE DOLOMITE

LEGEND

PERIOD	SYMBOL	DESCRIPTION
CAMBRIAN	€ep	EMINENCE DOLOMITE, POTOSI DOLOMITE
	€eb	FRANCONIA AND BONNETERRE FORMATION: INTERBEDDED LIMESTONE, CHERTY LIMESTONE, DOLOMITE AND SILTSTONE
	€lm	LAMOTTE SANDSTONE
PRECAMBRIAN	i	ST. FRANCOIS MOUNTAINS INTRUSIVE
	V	ST. FRANCOIS MOUNTAINS VOLCANIC
	U / D	NORMAL FAULT
	U / D	INFERRED FAULT

U = UPTHROWN SIDE; D = DOWNTHROWN SIDE



SEISMIC ZONE MAP
of
CONTIGUOUS STATES

SEISMIC PROBABILITY		
ZONE	DAMAGE	COEFF.
0	NONE	0
1	MINOR	0.025
2	MODERATE	0.05
3	MAJOR	0.10
4	GREAT	0.15

X APPROXIMATE LOCATION OF BIG LAKE DAM

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

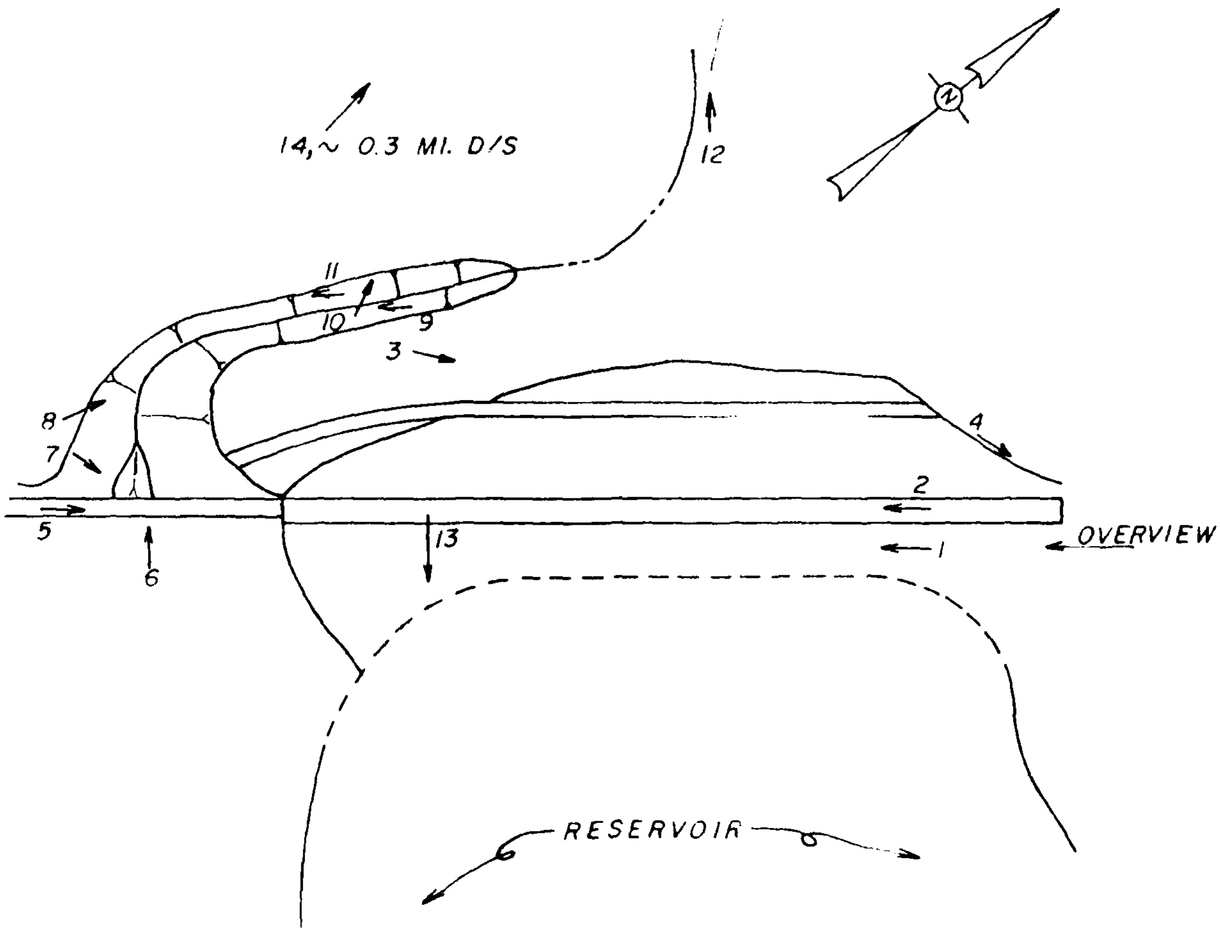


PHOTO INDEX
FOR
BIG LAKE DAM

Photo 1 - View of the upstream slope from the right abutment.

Photo 2 - View of the top of dam from the right abutment.

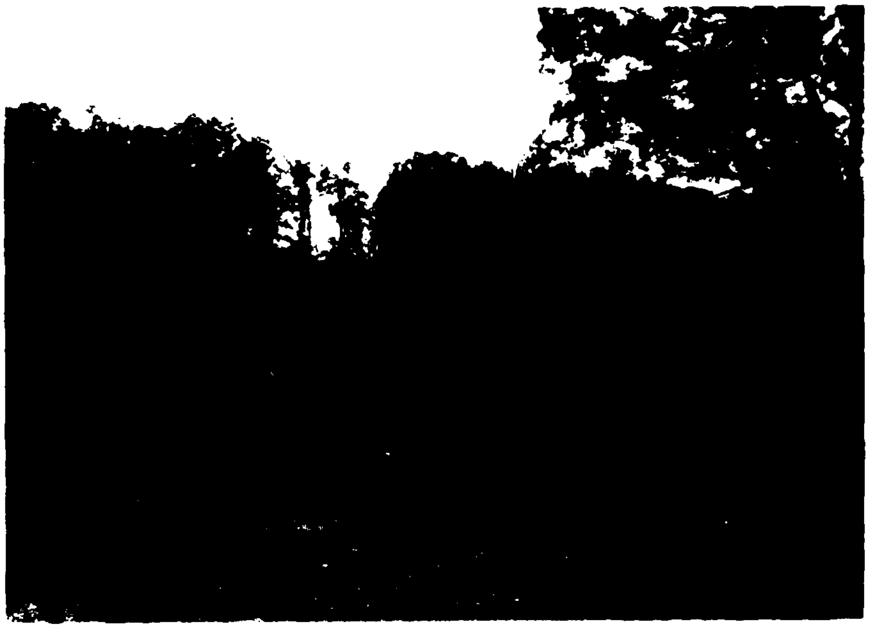


Photo 3 - View of the downstream slope from the spillway discharge channel area. Note the large cut near the toe of the dam.

Photo 4 - Close-up view of erosion along the downstream, right abutment/embankment contact.

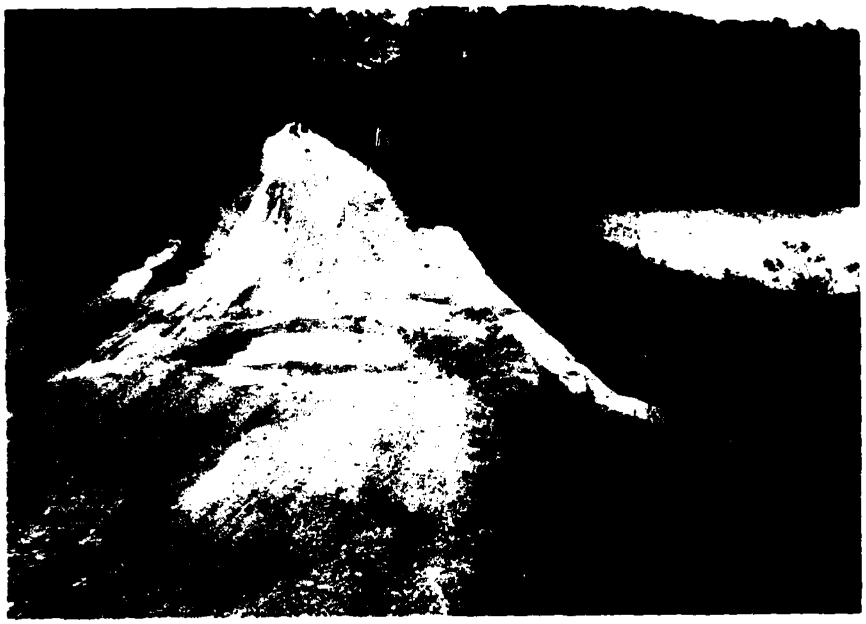


Photo 5 - View of the spillway broad-crested weir and concrete wall inlet looking from the left abutment.

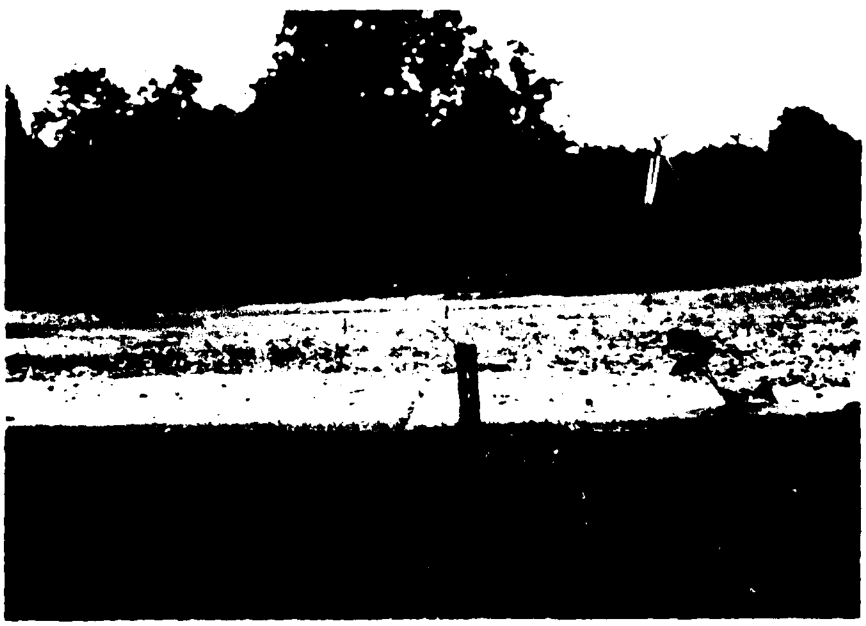


Photo 6 - Close-up view of a crack in the concrete wall inlet of the spillway.

Photo 7 - View of the spillway discharge channel. Note the erosion and concrete debris.

Photo 8 - View of the spillway discharge channel looking downstream. Note the erosion and the debris.

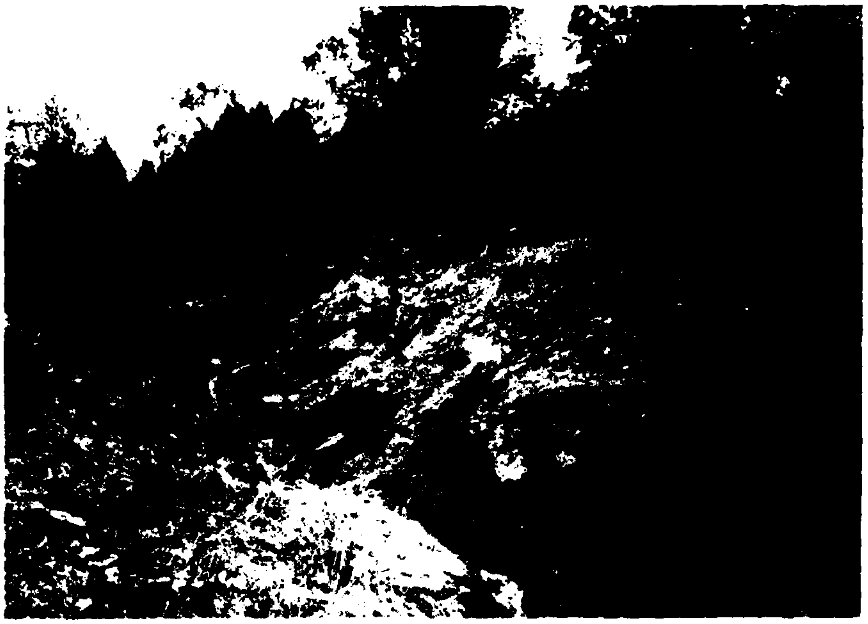


Photo 9 - View of the spillway discharge channel looking upstream. Note the erosion and the outcropping of bedrock.

Photo 10 - View of an outcropping of weathered dolomite bedrock in the spillway discharge channel.

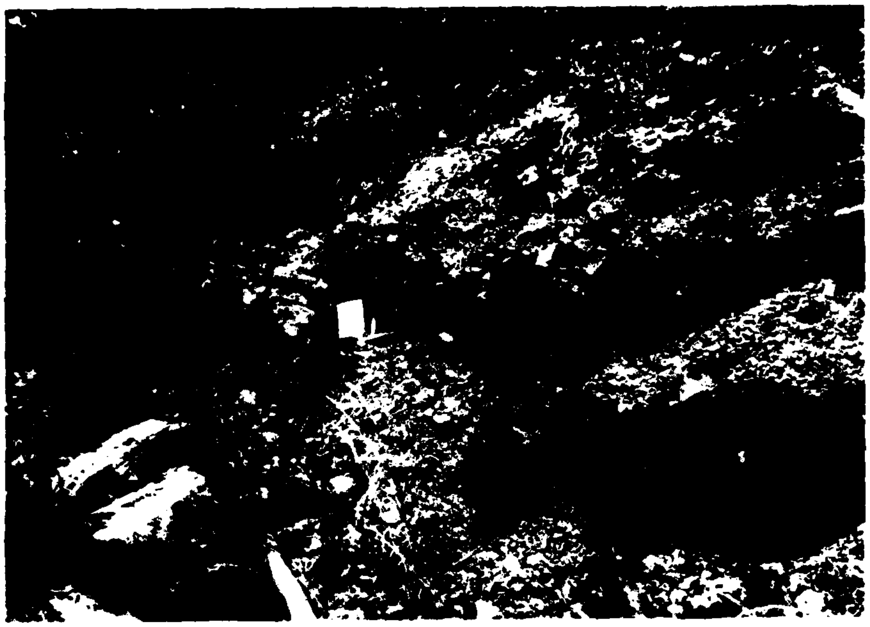


Photo 11 - View of an outcropping of weathered dolomite bedrock in the spillway discharge channel.

Photo 12 - View of the downstream channel.

Photo 13 - View of the reservoir and rim.

Photo 14 - View of dwellings in the downstream hazard zone at the upper end of Sunrise Lake.

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

BIG LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph procedures and the HEC-1DB computer program are used to develop the inflow hydrographs. The hydrologic inputs are as follows:

   (a) 24-hour Probable Maximum Precipitation from Hydrometeorological Report No. 33, and 24-hour 100-year rainfall and 24-hour 10-year rainfall of Ste. Genevieve, Missouri.

   (b) Drainage area = 0.42 square miles.

   (c) Lag time = 0.14 hours.

   (d) Hydrologic Soil Group: Soil Group "C".

   (e) Runoff curve number: CN = 73 for AMC II and CN = 87 for AMC III.

2. Flow rates through the spillway are based on assuming critical depth at the weir crest. Flow rates over the dam are based on the broad-crested weir equation $Q = CLH^{3/2}$ and critical depth assumption, in accordance with the procedures used in the HEC-1 computer program.

3. The spillway and the dam overtop rating curves are hand calculated and combined as shown on pages B-4 and B-5. This combined rating curve is input into HEC-1DB on the Y4 and Y5 cards. The $L and $V cards are, therefore, not used.

4. Floods are routed through Big Lake to determine the capability of the spillway.

5. Critical assumptions concerning channel flow and breach parameters were made in accordance with the hydrologic and hydraulic guidelines provided by the St. Louis Corps of Engineers.

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF 1

DAM NAME: Big Lake Dam (Mo. 30457) — JOB NO. 1283

UNIT HYDROGRAPH PARAMETERS — BY JFK DATE 5/12/81

1) DRAINAGE AREA, $A = 0.42$ sq. mi = (267.0 acres)

2) LENGTH OF STREAM, $L = (2.0'' \times 2000' = 4000') = 0.76$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 1005$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 799$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 940$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 800$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.047$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = [11.9 \times 0.76^3/206]^{0.385} = 0.24$ hr

B) BY VELOCITY ESTIMATE,

SLOPE = 4.7% $\Longrightarrow$ AVG. VELOCITY = 4 fps

$t_c = L/V = 4000' / 4\ fps \times hr/3600s = 0.28$ hr

USE $t_c = 0.24$ hr

9) LAG TIME, $t_\ell = 0.6\ t_c = 0.14$ hr

10) UNIT DURATION, $D \leq t_\ell / 3 = 0.05$ hr. < 0.083 hr.

USE $D = 0.083$ hr

11) TIME TO PEAK, $T_p = D/2 + t_\ell = 0.18$ hr

12) PEAK DISCHARGE,

$q_p = (484 \times A)/T_p = 484 \times 0.42/0.18 = 1130$ cfs

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri — SHEET NO 1 OF 1

Big Lake Dam (Mo. 30457) — JOB NO 1283

Reservoir Elevation - Area Data — BY JFK DATE 5/18/81

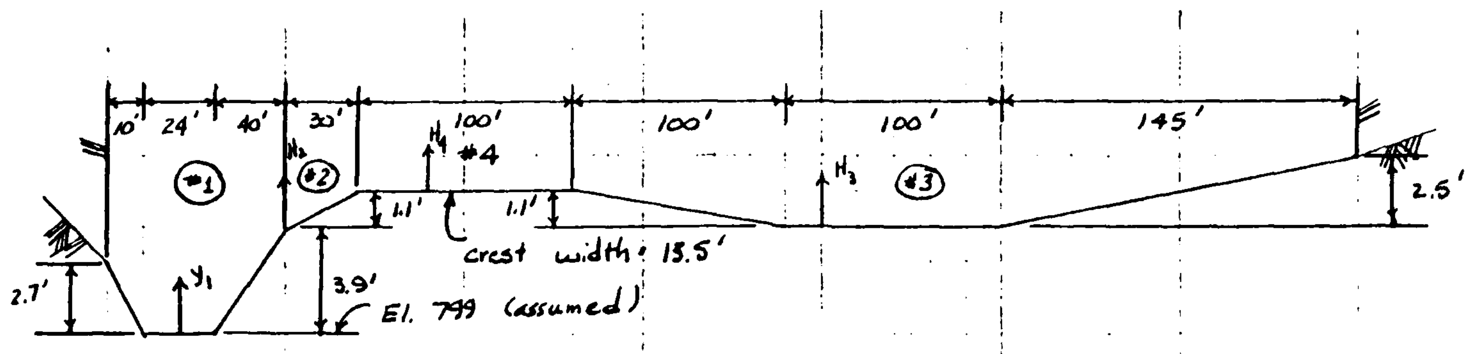
Elevation (ft, MSL)	Area (acres)	Remarks
770.	0.	Estimated Streambed U/S of dam
780.	1.5	Interpolated
790	4.5	Interpolated
799	10.0	Spillway Crest (assumed)
800	14.5	Measured from U.S.G.S. 7.5' Quad
802.9	20.5	Minimum Top of Dam
810	27.0	Interpolated
820	33.5	Measured from U.S.G.S. 7.5' Quad

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

Dam Safety Inspection - Missouri — SHEET NO. 1 OF 3

Big Lake Dam (Mo. 30457) — JOB NO. 1283

Spillway and Overtop Rating Curve — BY JFK DATE 5/18/81



Section #1*: for $0 < y_1 \leq 2.7$

$A_1 = 24.0 y_1 + 7.0 y_1^2$
$T_1 = 24.0 + 14.0 y_1$

for $2.7 < y_1 \leq 3.9$

$A_1 = 34.0 y_1 + 5.1 y_1^2 - 13.5$
$T_1 = 34.0 + 10.3 y_1$

for $3.9 < y_1$; W.S.EL = $799. + y_1 + V_1^2/2g$

$A_1 = 74.0 y_1 - 91.5$
$T_1 = 74.0$

Section #2*: for $0 < y_2 \leq 1.1$

$y_2 = 4/5 H_2$
$A_2 = 13.6 y_2^2$
$T_2 = 27.3 y_2$

for $1.1 < y_2$

$y_2 = 2/3 (H_2 + 0.3)$
$A_2 = 30.0 y_2 - 16.5$
$T_2 = 30.0$

; H_2 = W.S.EL - 802.9

B-4

Section #3*: for $0 < y_3 \leq 1.1$

$A_3 = 100.0 y_3 + 74.5 y_3^2$
$T_3 = 100.0 + 148.9 y_3$

for $1.1 < y_3 \leq 2.5$

$A_3 = 200.0 y_3 + 29.0 y_3^2 - 55.0$
$T_3 = 200.0 + 58.0 y_3$

for $2.5 < y_3$; $y_3 = H_3 - V_3^2/2g$, $H_3 = H_2$

$A_3 = 346.0\, y_3 - 236.3$
$T_3 = 345.0$

Section #4 : $Q = CLH_4^{1.5}$; H_4 = W.S.EL - 804.

* critical depth assumed, $Q = \sqrt{A^3 g / T}$

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri — SHEET NO. 2 OF 3

Big Lake Dam (Mo 30457) — JOB NO. 1283

Spillway and Overtop Rating Curve — BY JFK DATE 5/19/81

y_1	A_1	T_1	V_1	Q_1	W.S.EL.	H_2	Y_2	A_2	T_2	Q_2	$Q_{SUBTOTAL}$
0	0	0	0	0	799.0						0
0.1	2.5	25.4	1.8	4.4	799.2						4
0.3	7.8	28.2	3.0	23.4	799.4						23
0.5	13.7	31.0	3.8	52.0	799.7						52
0.8	23.7	35.2	4.7	110.2	800.1						110
1.0	31.0	38.0	5.1	158.8	800.4						159
1.3	43.0	42.1	5.7	246.4	800.8						246
1.5	51.7	44.9	6.1	314.7	801.1						315
1.8	65.8	49.1	6.6	432.3	801.5						432
2.0	75.9	51.9	6.9	521.0	801.7						521
2.3	92.1	56.1	7.3	669.9	802.1						670
2.5	103.6	58.9	7.5	780.0	802.4						780
2.8	121.9	62.7	7.9	964.4	802.8	0	0	0	0	0	964
3.0	134.7	64.8	8.2	1101.7	803.0	0.1	.08	.09	2.2	0.1	1102
3.3	154.5	67.8	8.6	1323.6	803.4	0.5	.4	2.2	10.9	5.5	1329
3.5	168.3	70.0	8.8	1482.2	803.7	0.8	.6	5.6	17.5	17.9	1500
3.8	189.8	73.0	9.2	1736.3	804.1	1.2	1.0	12.6	26.2	49.4	1786
4.0	204.5	74.0	9.4	1929.1	804.4	1.5	1.2	19.0	30.0	85.8	2015
4.5	241.5	74.0	10.3	2475.6	805.1	2.2	1.7	33.0	30.0	196.4	2672
5.0	278.5	74.0	11.0	3065.8	805.9	3.0	2.2	44.0	30.0	355.4	3421

W.S.EL.	H_3	Y_3	A_3	T_3	V_3	Q_3	H_4	C	Q_4	Q_{TOTAL}
799.0										0
799.2										4
799.4										23
799.7										52
800.1										110
800.4										159
800.8										246
801.1										315
801.5										432
801.7										521
802.1										670
802.4										780
802.8	0	0	0	0	0	0				964
803.0	0.1	.07	7.4	110.4	1.5	10.8				1113
803.4	0.5	.35	44.1	152.1	3.1	134.8				1464
803.7	0.8	.58	83.0	186.4	3.8	314.6	0	0	0	1815
804.1	1.2	.88	145.7	231.0	4.5	656.3	0.1	2.93	9.3	2451
804.4	1.5	1.12	205.4	265.0	5.0	1026.1	0.4	3.01	76.0	3117
805.1	2.2	1.61	342.2	293.4	6.1	2096.9	1.1	3.04	350.3	5119
805.9	3.0	2.20	525.4	327.6	7.2	3775.2	1.9	3.04	797.4	7994

ECI-4 PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection - Missouri SHEET NO 3 OF 3
Big Lake Dam (Mo. 30457) JOB NO. 1283
Spillway and Overtop Rating Curve BY JFK DATE 5/19/81

Check critical depth assumption in spillway channel:

for $Q_c = 110.2$,

$y = 0.8$
$A = 23.7$
$P_w = 35.2$
$n = 0.025$

$$Q_c = \frac{1.49}{n} R^{2/3} S_c^{1/2} A$$

$$S_c = \left[\frac{Qn}{1.49} \frac{1}{R^{2/3}} \frac{1}{A}\right]^2$$

$$S_c = \left[\frac{110.2\ (0.025)}{1.49} \frac{1}{\left(\frac{23.7}{35.2}\right)^{2/3}} \frac{1}{23.7}\right]^2 = 0.010$$

mildest slope in channel = $0.7/24 = 0.029 > 0.010$

$\therefore$ critical depth assumption is valid

SUMMARY OF PMF AND ONE-HALF PMF ROUTING

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
 LAST MODIFICATION  01 APR 80
**********************************
     1            A1      DAM SAFETY INSPECTION - MISSOURI
     2            A2        BIG LAKE DAM (MO.30457)
     3            A3        PMF AND ONE-HALF PMF
     4            B    300        0      5      0      0      0      0      0      0      0
     5            B1     5
     6            J      1        2      1
     7            J1     1       .5
     8            K           BIGLK                                       1
     9            K1      RUNOFF CALCULATION FOR BIG LAKE DAM DRAINAGE AREA
    10            M      1        2    .42           .42      1                   1
    11            P              26    100    120    130
    12            T                                                      -1    -87
    13            W2            .14
    14            X                      1
    15            K      1    BIGLK                                       1
    16            K1      ROUTE HYDROGRAPH THROUGH BIG LAKE
    17            Y                             1      1
    18            Y1     1                                             -799     -1
    19            Y4   799    799.2  799.4  799.7  800.1  800.4  800.8  801.1  801.5  801.7
    20            Y4 802.1    802.4  802.8  803.0  803.4  803.7  804.1  804.4  805.1  805.9
    21            Y5     0        4     23     52    110    159    246    315    432    521
    22            Y5   670      780    964   1113   1464   1815   2451   3117   5119   7994
    23            $A     0      1.5    4.5     10   14.5   20.5     27   33.5
    24            $E   770      780    790    799    800  802.9    810    820
    25            $$   799
    26            $D 802.9
    27            K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	799.00	799.00	802.90
STORAGE	97.	97.	150.
OUTFLOW	0.	0.	1039.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	804.88	1.98	202.	4483.	1.67	15.75	0.00
.50	803.49	.59	172.	1571.	.50	15.83	0.00

PERCENT OF PMF ROUTING
EQUAL TO SPILLWAY CAPACITY

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************************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION   01 APR 80
************************************
A1           DAM SAFETY INSPECTION - MISSOURI
A2               BIG LAKE DAM (MO.30457)
A3               PERCENT PMF
B     300       0       5       0       0       0       0       0      -4       0
B1      5
J       1       4       1
J1     .3     .35     .38      .4
K             BIGLK                                     1
K1           RUNOFF CALCULATION FOR BIG LAKE DAM DRAINAGE AREA
M       1       2     .42             .42       1                       1
P              26     100     120     130
T                                                      -1     -87
W2            .14
X                       1
K       1     BIGLK                                     1
K1           ROUTE HYDROGRAPH THROUGH BIG LAKE
Y                               1       1
Y1      1                                            -799      -1
Y4    799   799.2   799.4   799.7   800.1   800.4   800.8   801.1   801.5   801.7
Y4  802.1   802.4   802.8   803.0   803.4   803.7   804.1   804.4   805.1   805.9
Y5      0       4      23      52     110     159     246     315     432     521
Y5    670     780     964    1113    1464    1815    2451    3117    5119    7994
SA      0     1.5     4.5      10    14.5    20.5      27    33.5
SE    779     780     790     799     800   802.9     810     820
SS    799
SD  802.9
K      99
```

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	799.00	799.00	802.90
STORAGE	97.	97.	160.
OUTFLOW	0.	0.	1039.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.30	802.39	0.00	150.	775.	0.00	15.92	0.00
.35	802.73	0.00	157.	932.	0.00	15.92	0.00
.38	802.91	.01	160.	1048.	.08	15.92	0.00
.40	803.02	.12	163.	1135.	.25	15.92	0.00